Build Your Own Tandem

by Rodney Moseman

PREFACE--In this series of articles I will try to describe the process of designing and constructing a tandem frameset. Since 1976 I have built over fifteen tandems and assisted several beginners in building theirs. Throughout those years I have felt a deep satisfaction upon completion of each frameset and have shared a similar joy of accomplishment helping others.

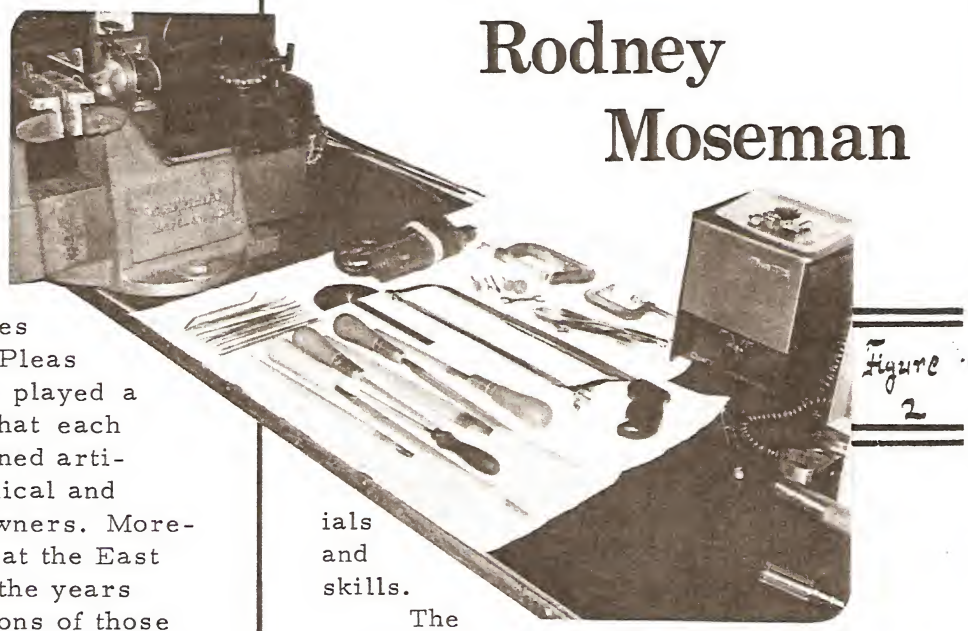


Figure 2

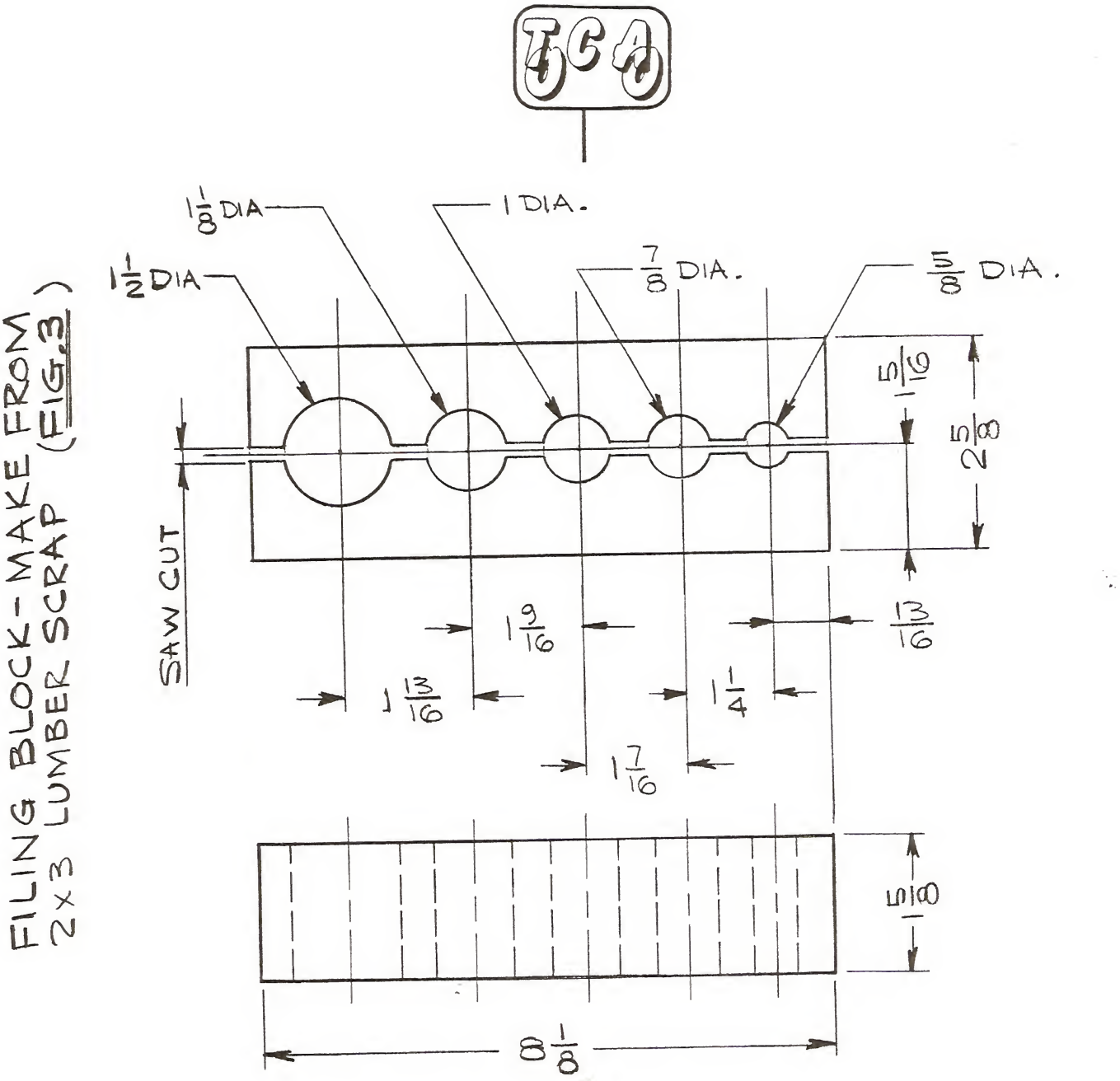
The idea for this series was a long time in coming. Pleas for articles from this editor played a big part. Also, it seemed that each issue of "Doubletalk" contained articles pointing out the mechanical and inventive skills of tandem owners. Moreover, meeting many of you at the East Coast Tandem Rallies over the years has reinforced my impressions of those skills. I believe many of you would eagerly tackle this type of project if some guidelines were laid out directing prospective builders on how to obtain materials and skills.

The final inspiration for this series came at last year's New York bicycle show when the Haden Co. of England showcased a prototype

Tool List

1. Sturdy Workbench
2. Vise
3. Soft Jaws for vise
4. Hacksaw with 32T blade
5. Files
   a.) 6" round bastard cut
   b.) 6" half round second cut
   c.) 10" half round bastard cut
   d.) 6" round bastard cut
   e.) 6" round second cut
   f.) 10" round bastard cut
   g.) 10" round second cut
   h.) riffle set
6. File handles for A to G
7. Dremel or similar hand grinder with assorted burrs & abrasives
8. Oxygen/acetylene torch or Equiv.
9. Adjustable protractor
10. Vise Grips
11. "C" clamps
12. 1/4" electric drill
13. drill bits (1/16 to 1/4 set)

figure 1



lugset for tandems. Because a lugged frame is much simpler to construct than a lugless one, I selected this style to illustrate in this series. Later, toward the end of these writings, I will do a piece on lugless construction. At this time I am awaiting shipment of a Haden lugset, so I hope to have them in hand to be able to advise you of their cost and availability in the next issue.

In the meantime, we begin the groundwork of obtaining tools and learning detailed information.

TO BUILD A TANDEM you can be proud of requires a great deal of skill, patience, and perseverance. So do not be put off by learning skills in areas in which you are probably unfamiliar. You can do it! And there is help out

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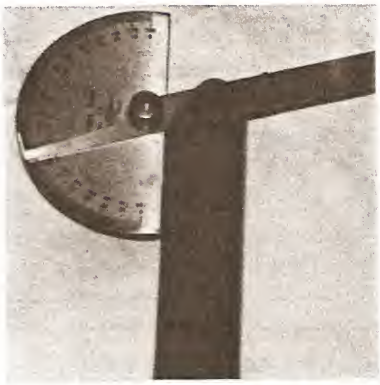
Figures 4, 5, 6



there. To start I recommend Richard P. Talbot's book entitled Designing and Building Your Own Frameset, as one of the best I have read. Consider it a must for this project. The cost is $18.00 and you can order it directly by writing: The Manet Guild, 310 Franklin Street, Dept. 535 (N-82), Boston, MA. 02110.

PRACTICE, practice, practice...but how to start? If you are unaccustomed to using a torch, many local school systems offer evening classes in oxygen acetylene welding. While this can be an excellent place to gain hands-on experience, I suggest you discuss with the instructor the areas in which you are mainly interested--specifically, brazing and silver soldering.

Metal working skills can also be obtained at evening classes. A machine shop course would be of value, but with limitations. Since we will be using hand tools, such as a hacksaw and files, I feel that with a little practice at home you can gain the "feel" that is necessary for this work.

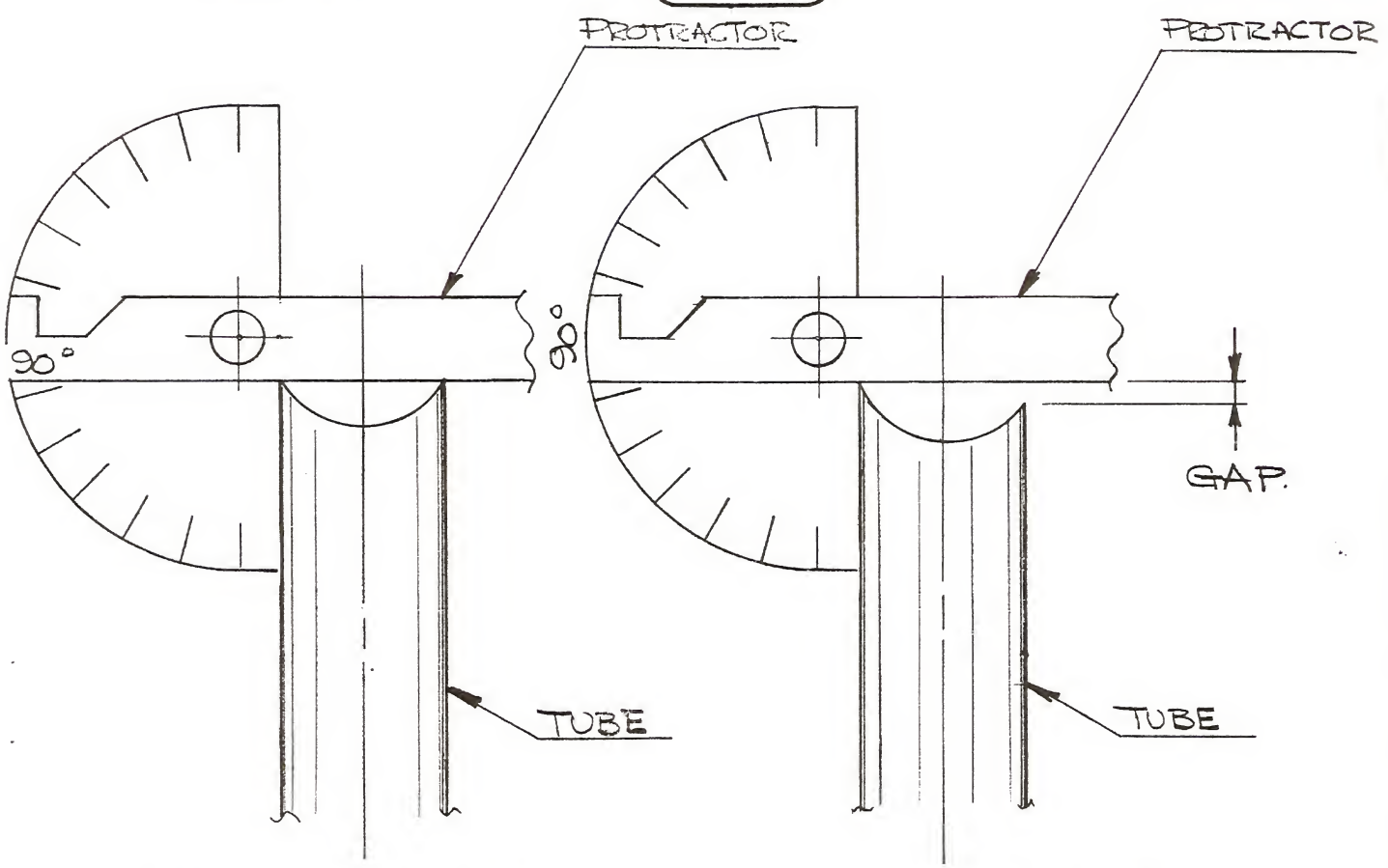
There also may be a framebuilder in your area who is willing to assist you. Keep in mind that time he spends with you is part of his livelihood and some form of compensation would be in order.

THE TOOL LIST--The photographs and illustrations in figures 1 and 2 give some idea of the tools that will be required. There will also be some special tools, jigs, and alignment gauges that will have to be made. One such tool is the filing block (shown in figure 3). Plans for the jigs and alignment gauge will accompany future articles in this series. Meanwhile, proceed with the filing block.

To get acclimated try to obtain a trashed frame from your local bike dealer's junk pile. Cut the main tubes close to the lugs and use these tubes to practice your mitering skills. A simple exercise is to cut the salvaged frame tubes into six inch lengths and practice filing miter joints so that the end of one tube joins another tube at an angle of 90°, 73°, or 60°. The photograph (fig. 4) shows the steps for mitering a tube.

From left to right, we see the tube-end as cut; in the center, the end of the tube is rough-shaped by taking cuts with a hacksaw to eliminate excessive filing; on the right, the tube is filed to conform to the shape of the tube that will butt against it. The photos in figures 5 and 6 show the mitered end being checked with a protractor. It is necessary for the miter to be the correct angle, as well as centered on the tube. The sketch (fig 7) illustrates a centered and off-center miter.

FIG. 7



MITER ON CENTER

MITER OFF CENTER

After trying several miters, you may start to feel a little cocky about how simple it is to master a single-end miter. The fun part is to miter the other end so that the center line dimension between adjoining tubes is correct and the miters are parallel or perpendicular depending upon the function of that tube. So now you can try mitering the other ends and, to make these exercise even more interesting, do the second end-miter to a predetermined dimension, similar to the type of miters found on both ends of a top tube.

In the next article I will deal with frame design, materials we will be using and, as mentioned earlier, the alignment fixture and jigs. The first project for your tandem frameset will be constructing a rear handlebar stem.

So until next issue, have patience, research the project by reading all you can in the suggested book, and any other pertinent books and magazines.

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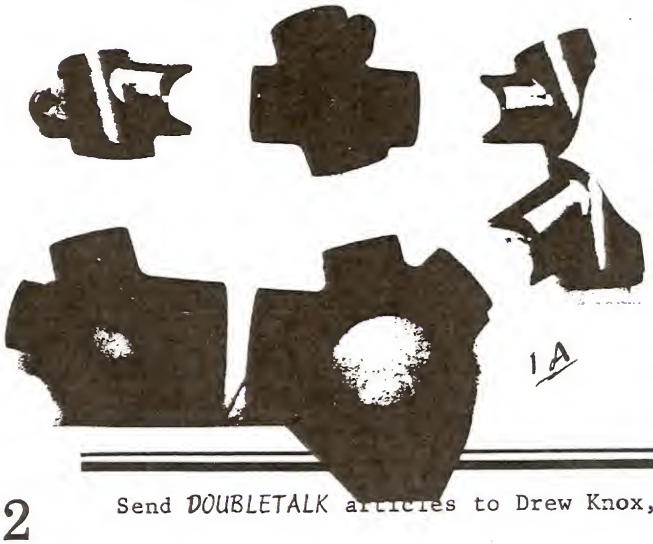
BUILD A CUSTOM TANDEM FRAME

PART II
by Rodney Moseman

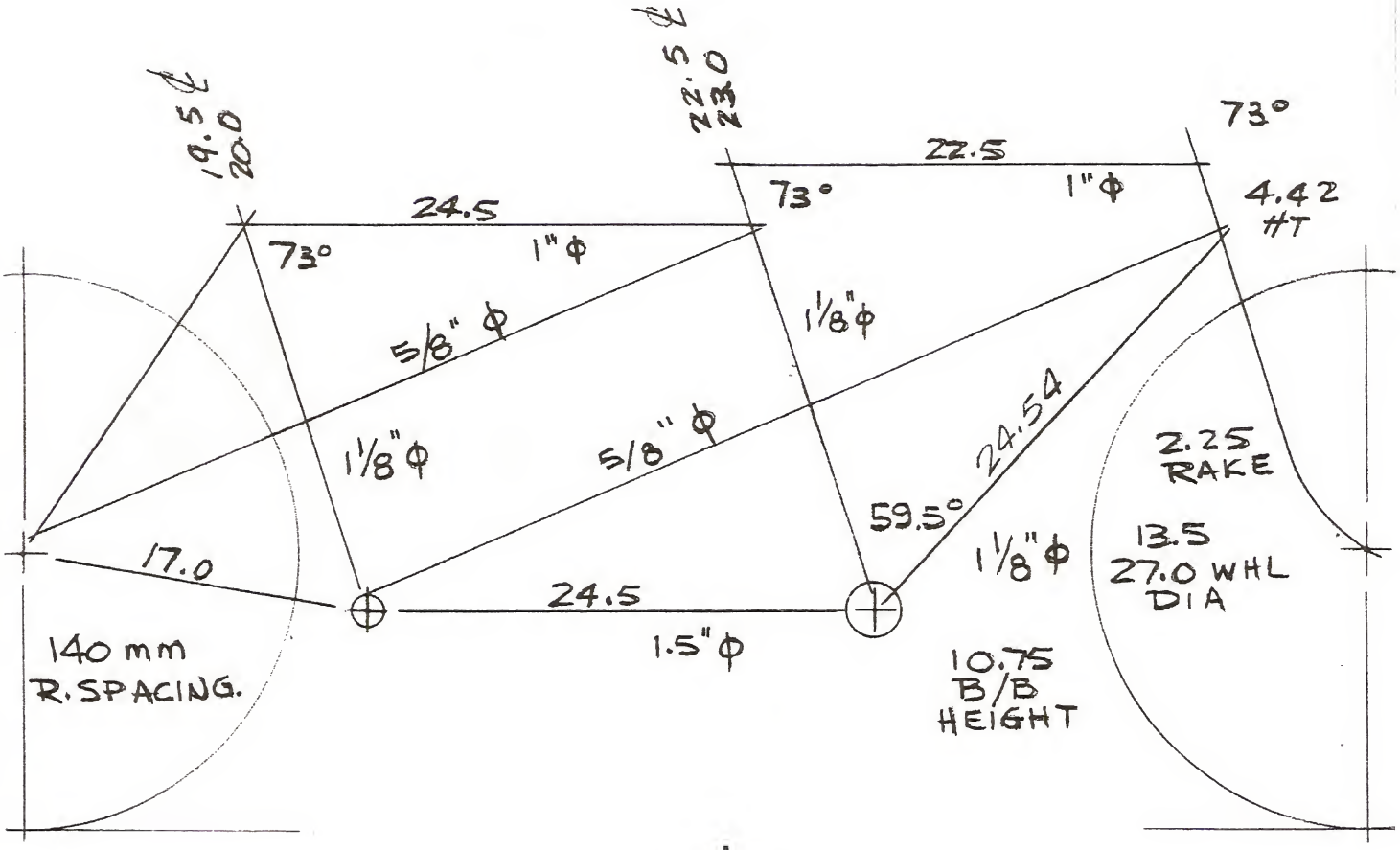
The frame that I will be building while penning this series is a step frame design with front and rear top tubes parallel to the ground but at different heights to accomodate differing inseam measurements (Fig #2) of the captain and stoker. Let me reiterate that Richard Talbot's book Designing & Building Your Own Frameset is an indispensable tool for your tandem project. Before construction begins, you must know what you are going to build. In other words, make a carefully detailed plan showing dimensions and materials. Remember the 7 Ps: Proper Prior Planning Prevents Piss-Poor Performance.



Since my first article, I received the long-awaited Haden lugset. My first impression was one of disappointment; in a word they are ugly. The two bottom brackets, as well as the front seat tube lug, are castings. (Figure #1A) The lugs are bulky and in need of help (as in Fig 1B), but Fig 1C demonstrates the wonders that can be achieved with a file.

While planning your tandem dimensions, you may want to experiment with your present bicycle(s) to derive seat tube and top tube dimensions for the captain and stoker. If your present bikes feel right, record the top tube, seat tube and stem lengths for your layout or incorporate improvements for a better fit.

TANDEM LAYOUT SKETCH
FIG. 2



THE FIRST STEP in setting up your bike is to note the top tube clearance, or the space between your crotch and the top tube when you straddle the bike. One inch is the ideal clearance. Measure the top tube height from the floor to the centerline of the top tube making this measurement perpendicular to the floor. Adjust this figure to obtain the ideal one inch clearance. Don't forget to allow for the centerline of the top tube. The adjustment and measurement of seat height and fore/aft position can best be performed with assistance from a friend or two.

Have one friend hold the bike upright while the other friend makes measurements. Remove the toe clips and straps. Position seat height for proper leg extension which is having both heels on the pedals while sitting. Spin backwards with your feet on the proper side of the pedals, then lower the seat if you need to rock from side to side to keep your heels on the pedals, or raise the seat until your heels just stay on. With the pedals at a horizontal position, drop a plumbline that intersects the pedal shaft centerline. The seat is properly located fore and aft when the plumbline falls one inch behind the knee cap (Fig #3). Be sure that before making the fore/aft adjustment you are properly seated in a riding position. Sitting too far forward

or too far back will not give the dimensions you need.

A caution: making the fore/aft saddle adjustment can change the saddle height, so recheck the height to make sure it is right. If you cannot get proper fore/aft position because of your bike's adjustment, make a note of amount of adjustment you need for proper position. You may also want to allow for centering the saddle in the middle of the fore/aft range of the rails. This will allow for fine adjustments on the frame you will be building.

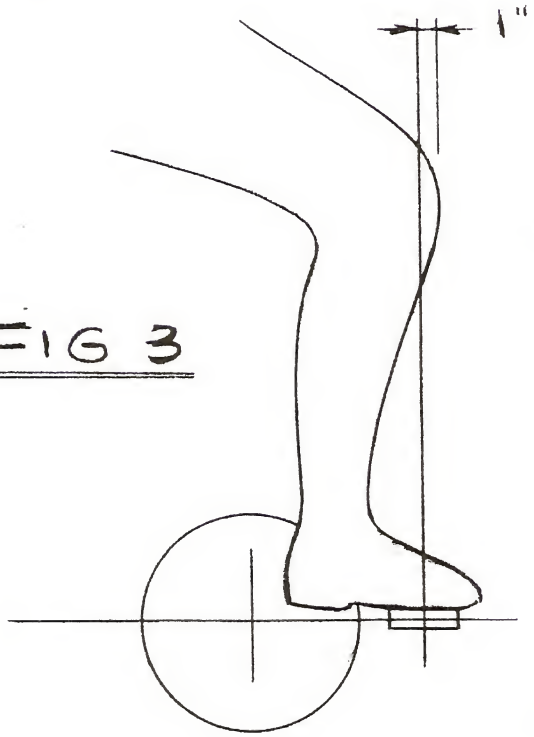


FIG 3

Next, take the top tube and stem measurements. The top tube length is correlative to upper body dimensions (torso and arm length). Place your hands in the drops in a position that allows you to reach and operate the brake levers. Relax your elbows. Then have someone observe your back position from the side. (A polaroid lets you examine the position yourself.) Your back should be at a 45 degree angle; thus a plumbline dropped from the tip of the nose should intersect one inch behind the handlebar centerline (Fig #4).

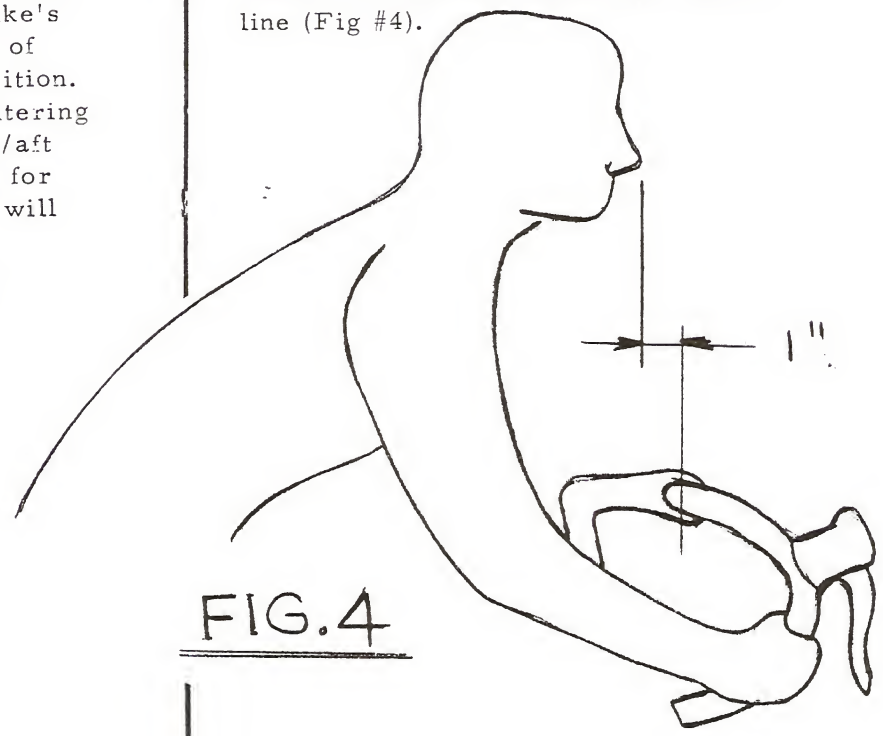


FIG.4

You will now be able to tell if the handlebars must be moved away or towards you. Also if they must be raised or lowered. Fore/aft adjustment can be made by the selection of the proper stem length. Changing the back angle from 45 degrees can tell you if the handelbars must be raised or lowered. I suggest making these changes on your single so that you will be in this riding position for awhile. Then you can make fine adjustments before using these dimensions in your plans.

Some folks with unusually long or short arms, relative to their torso, will find that with their backs at 45 degrees and the fore'aft position correctly set

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they cannot reach the bars. Since standard stems most readily available cannot be raised enough to get the riders in position, an extended stem must be used. Another solution is to slope the top tube so that the head tube is higher, allowing for more adjustment.

You, at this point, may decide that an adjustable stem will best allow you to zero in on a "custom" fit. Fig. #5 shows one that I use on my sizing stand. Additionally, the drawing in Fig. #6 gives dimensions for an adjustable stem. Try putting your newly learned brazing skills to work on this project. You may find your finished stem will be in demand by friends and fellow club members after you are finished using it.

Deriving stem and top tube dimensions for the stoker are done in the same manner. There is a practical limit to the distance between the front and rear bottom brackets of 25", so some compromise may have to be made here. Also, the rear stem should be at least 3 inches so the captain's legs won't hit it.

Compile your dimensions and make a scale drawing similar to the one shown in Fig. #2, which shows the frameset I will be building.

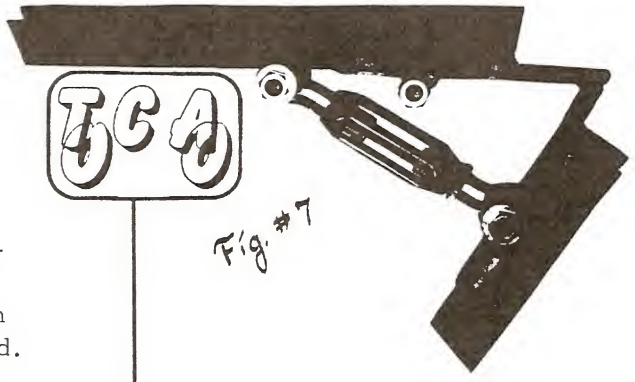


Fig #7

In the last article I neglected to explain the use of a filing block. This tool clamps the tube you are mitering firmly in a vise without crushing the tube.

One of the challenges in writing this article was to devise jigs and alignment fixtures that will be simple and inexpensive, since this is a hobby-type of project aimed at giving confidence and encouragement. While expensive jigs would certainly save time and guarantee a degree of accuracy, they are not that critical in this project as precision alignment will result by spending time checking and rechecking each step. Discrepancies will be corrected before proceeding to the next step. Your patience will result in a frame that is aligned and that will track true.

The angle jig shown in detail in Figs. # 7 & 8 can be built for about $15. It consists of a piece of angle iron, strap hinge, turnbuckle, machine bolts, nuts and flat washers. All of these materials are available at any good hardware store. One tip is that the angle iron be cut at the hinge joint after the hinge is brazed in place. This insures perfect alignment of the two segments. Another word of caution: hardware of this type is sometimes cadmium-plated as a means of rust protection. When vaporized, cadmium forms a deadly gas that can kill. If you cannot get unplated hardware, grind or file the plating off the areas being brazed. As a further precaution, work in a well ventilated area with an exhaust fan blowing fumes away.

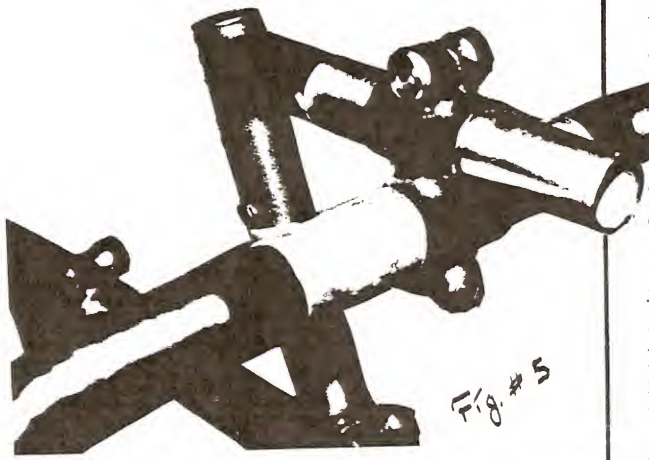


Fig #5

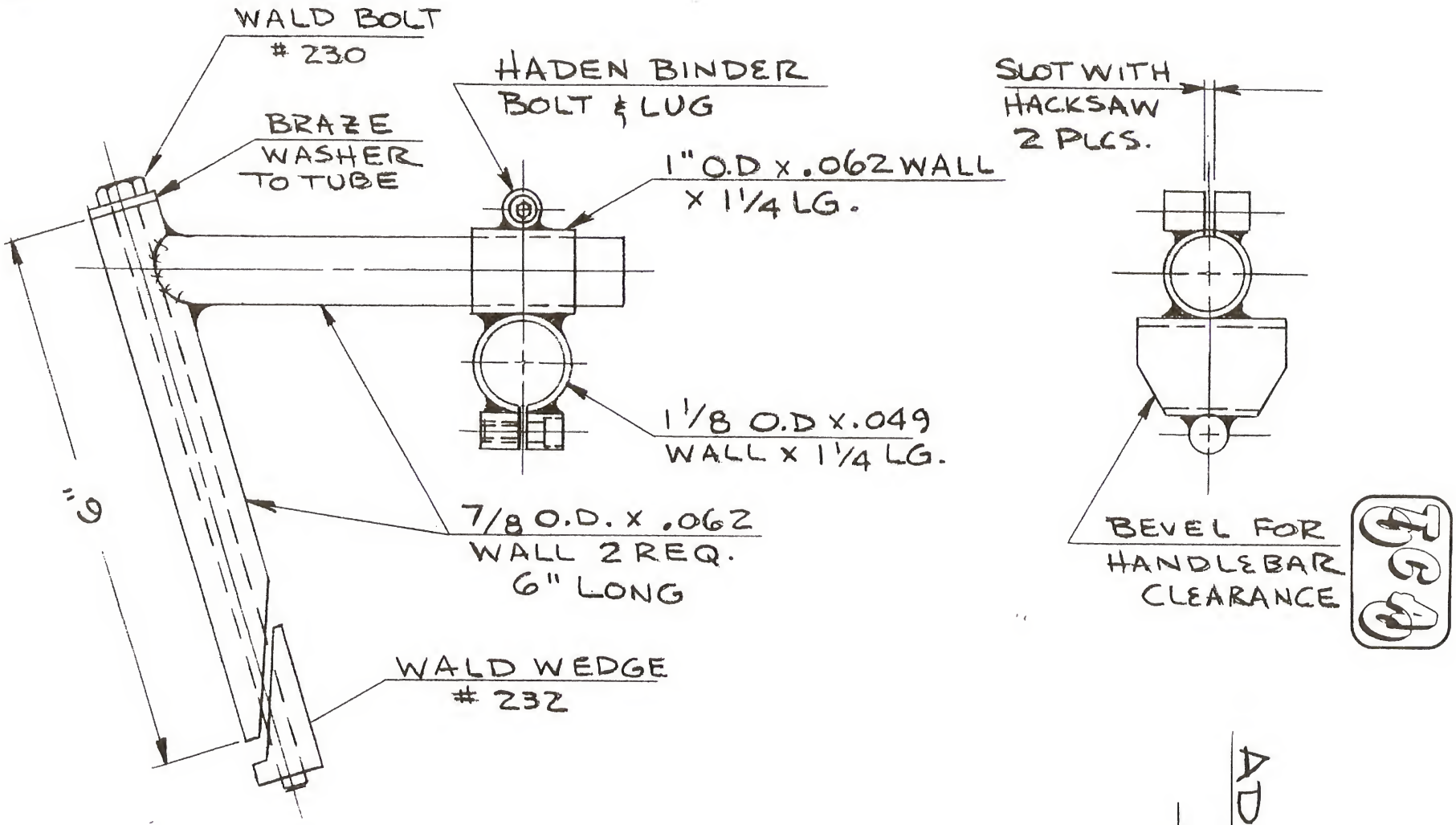


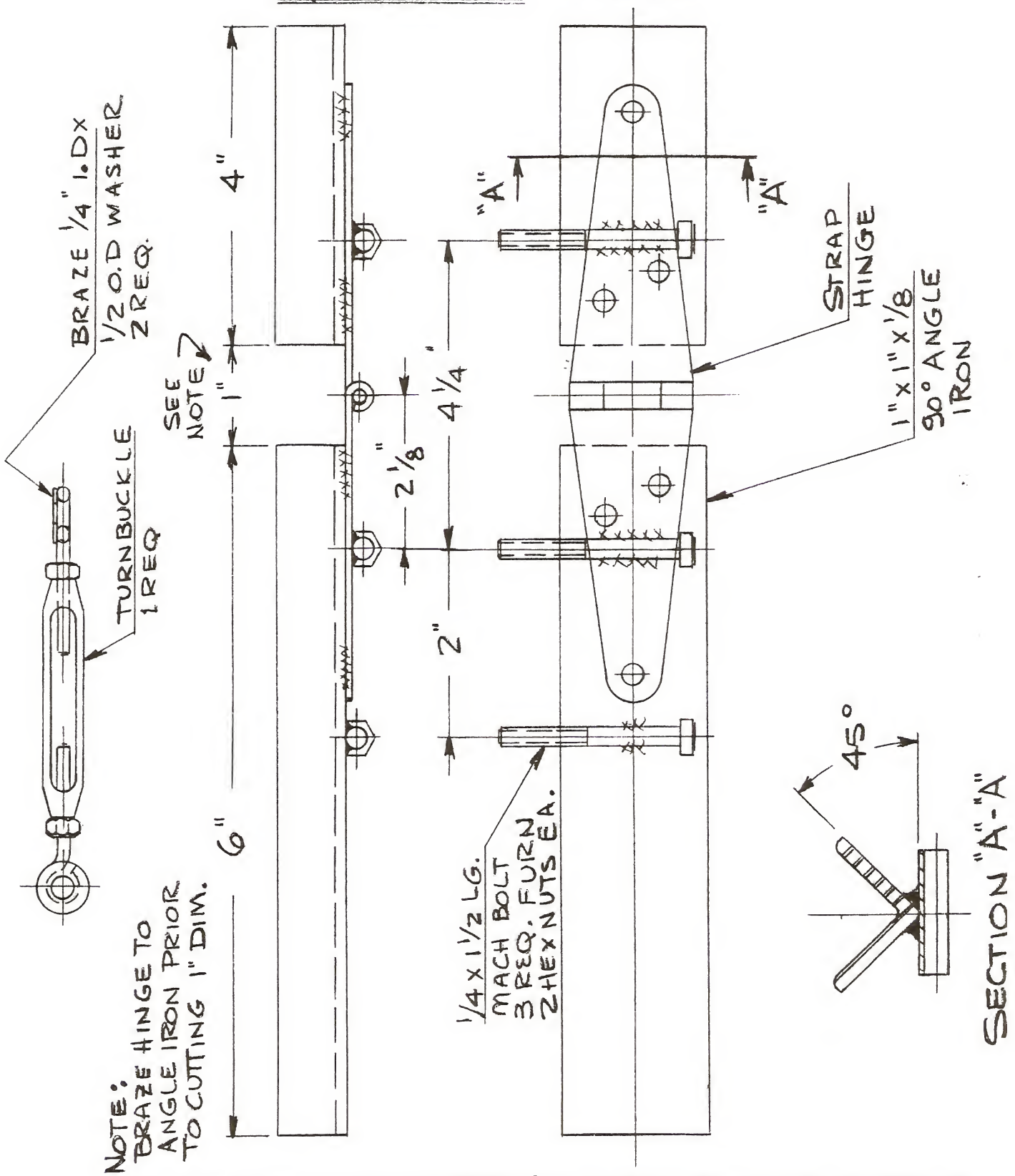
FIG 6

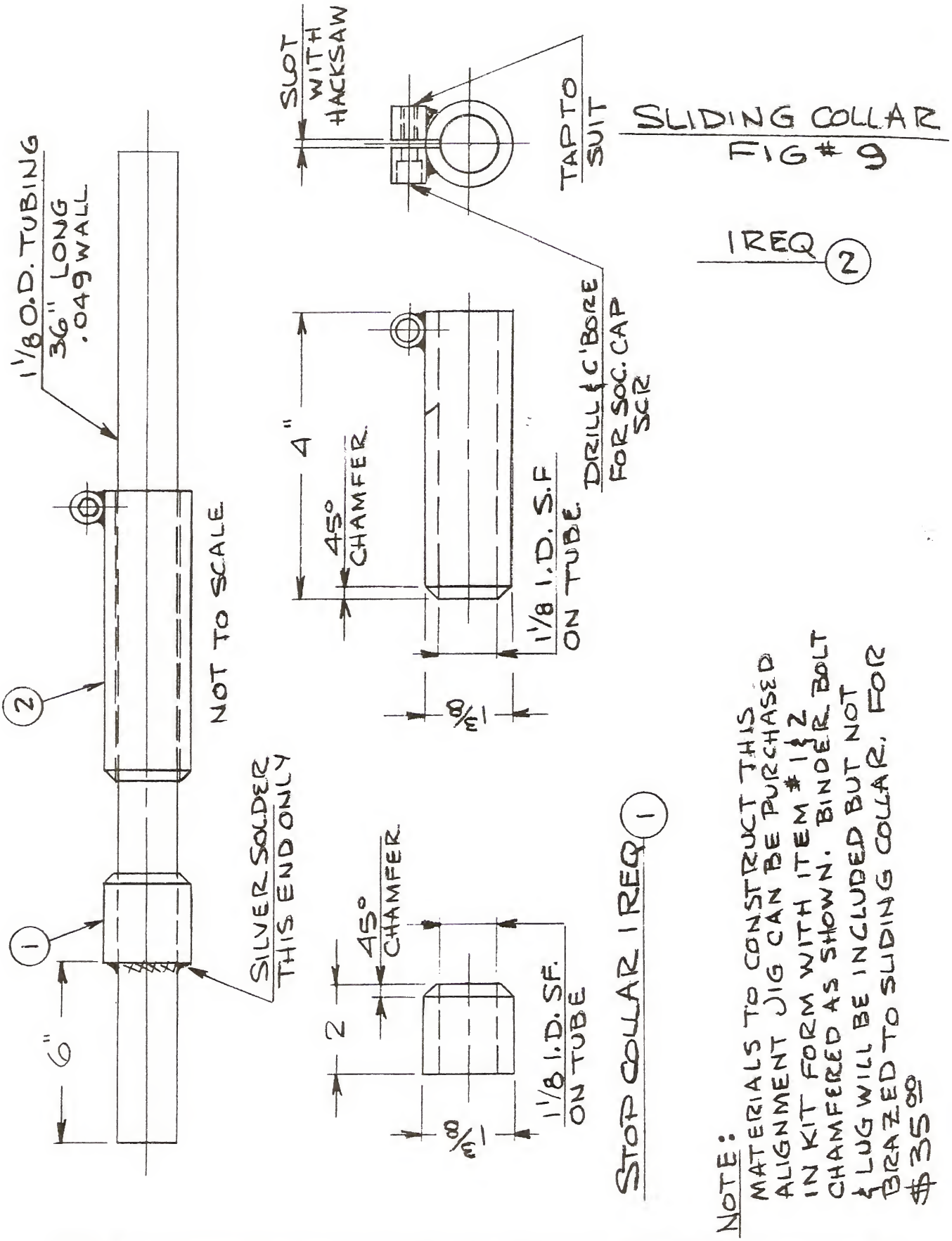
ADJUSTABLE STEM

NOTE:
MATERIALS TO CONSTRUCT THIS STEM CAN BE PURCHASED IN KIT FORM FOR $ 35.00

IDEA CAN BE ADAPTED TO STOKER STEM.

ANGLE JIG FIG #8

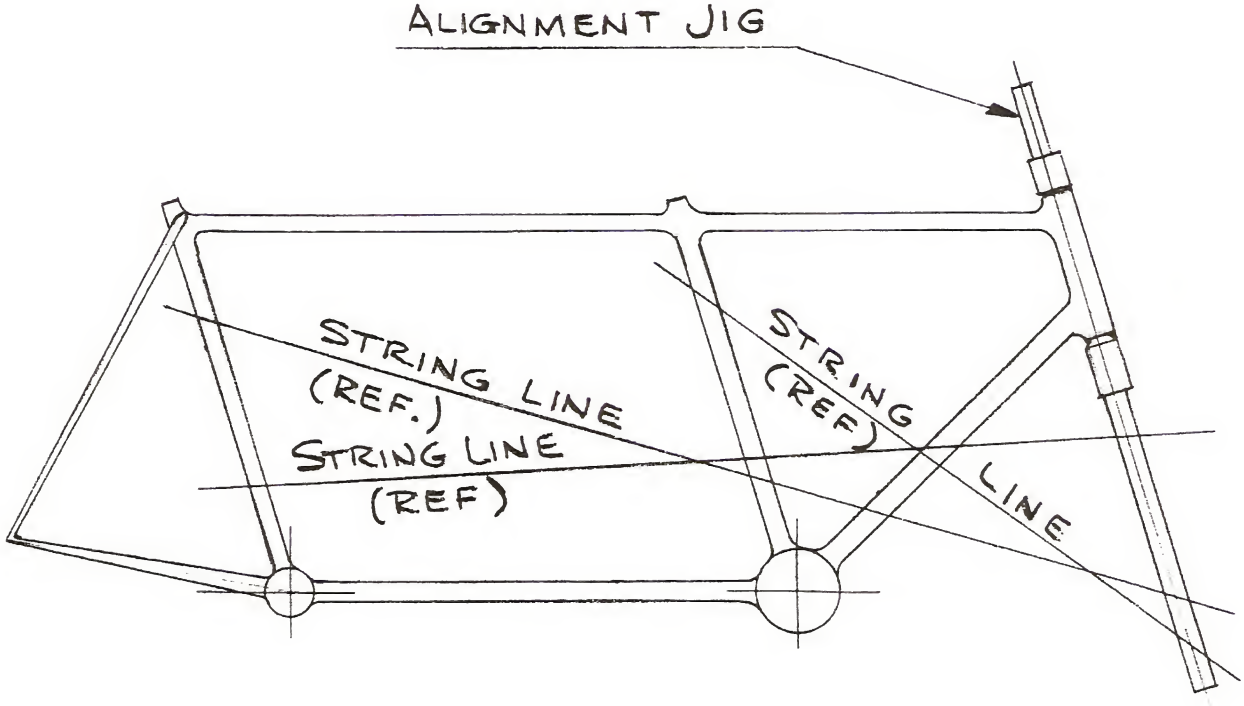



1 1/8 O.D. TUBING
36" LONG
.049 WALL
NOT TO SCALE
SILVER SOLDER THIS END ONLY
6"
SLOT WITH HACKSAW
TAP TO SUIT
SLIDING COLLAR
FIG # 9
1 REQ (2)
4"
45° CHAMFER
1 1/8 I.D. S.F ON TUBE
DRILL & C'BORE FOR SOC. CAP SCR
3/8"
STOP COLLAR 1 REQ (1)
2
45° CHAMFER
1 1/8 I.D. SF. ON TUBE
3/8"
NOTE:
MATERIALS TO CONSTRUCT THIS ALIGNMENT JIG CAN BE PURCHASED IN KIT FORM WITH ITEM # 1 & 2
CHAMFERED AS SHOWN. BINDER BOLT & LUG WILL BE INCLUDED BUT NOT BRAZED TO SLIDING COLLAR. FOR #3500

As the pictures show, this simple angle jig can be adjusted from 90° to 180° by changing the position of the turnbuckle from one stud to another and by adjusting it accordingly. Simple "C" clamps, or hose clamps, are used to hole the tubes in the "y" created by the angle iron.

While the angle jig can be easily understood by just studying the picture, the alignment jig requires more thought. It consists of a length of 1 1/8" O.D. tubing and another piece of tubing whose I.D. is a sliding fit over the first tube is cut as shown in Fig. #9. The resulting ends of this cut tube are faced. One end of each piece is faced square, the other end of each piece is faced at a 45° male chamfer. The facing of these pieces is almost the only operation in this project that requires a metal working lathe. If you do not have access to one, a local machine shop can do this operation or you can order the tubes faced from me, as noted on the bill of materials (Fig. #9).

Note on the drawing that the short



STRING CHECK USING ALIGNMENT JIG

FIG # 11

NOTE:
STRING CHECK MAY BE BEST PERFORMED BEFORE INSTALLING LATERAL TUBES

tube is silver soldered to the 1 1/8" O.D. tube about 6 inches from the end with the beveled end facing the long end. The other tube is free to slide on the 1 1/8" O.D. tube. The threaded lug brazed to this tube is slotted to allow clamping any place along the 1 1/8" OD tube. The alignment jig must be made from straight 1 1/8" OD tubing. Also note this is a jig that is used for checking only and is not used to cold set the frame.

Now, as to the alignment jig's use. The key to this jig is the 1 1/8" OD tube--the same O.D. as the seat tube and down tube. The jig is inserted from the top of the head tube of the frame so that the beveled end of the silver soldered collar centers itself in the head tube. The sliding collar is brought into position so that its beveled end fits into the lower end of the head tube and locks into position with the clamp screw. With the jig in place we are now able to establish the centerline of the head tube beyond the length of the head tube.

A simple string test made at several points between the seat tube and alignment jig will indicate if the head tube is parallel to the seat tube from the head on position. The point of reference will be the down tube. The string will have to be looped around both sides of the frame. Any gap at the down tube will indicate an alignment problem.

Fig. #12

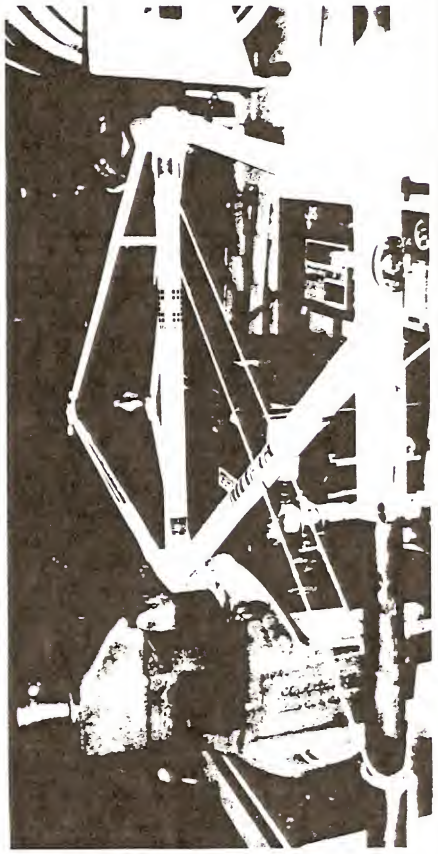


Fig. #10

Figs. #10 & 11 show the alignment jig used on a single and tandem frameset.

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Construction of the rear handebar stem is a good beginning project. Miter the tubes to the dimensions you have chosen (Figs. #12 & 13). Tack braze the pieces in position and check the alignment. If the alignment is right, build up a generous brass fillet as shown in Fig. #14. File and polish the joints (Fig. #15). A hacksaw is used to slot the ends so that the stem can be clamped on the seat post and handlebar. The adjustable stem can be made following the same procedure in Fig. #6.

Figure # 13

Fig. # 14 Top; # 15 Bottom

In part 3 we build the frame and fork. In the meantime reread the resource materials and practice your mitering and brazing skills.

BUILD A CUSTOM TANDEM FRAME

PART III
by Rodney Moseman

We reach the moment of truth. In this text I detail actual construction of a frameset. I suggest for those of you who have not read the first two parts of this series to write the editor for copies.

I have learned over the years some tips I can add at this point. As I share my experiences, you must realize that no matter how careful or vivid the description, nothing replaces experience and practice. Experience only comes by doing. So don't be afraid of making a mistake or doing something wrong. Try to accept the concept that a mistake is a powerful teaching tool.

FIGURE #2

Many times as I was growing up I heard elders recounting life's embarassing moments and the lessons learned with a fond glint in the eye. If you stop to think, your most dramatic learning experiences were probably the results of embarassment, physical pain or financial discomfort. So if you cut a tube too short, count it as a lesson you need to master further. I would venture to guess that there is not a framebuilder alive that has not mitered a top tube so that the angles, instead of being parallel, are actually directed towards each other. We all pray for some short customers so we can use up that odd short tube that haunts us on the shelf.

One mistake that is all too easy to make it so spend too much time visualizing the finished product without giving any thought to how the project will look at various stages of construction. A just-brazed or silver soldered joint can be a very discouraging sight when you have to clean and prepare it for the finished paint job. Take the project one step at a time and try to realize your limits of frustration. When you reach that limit, lay down your project and walk away while you are still in control.

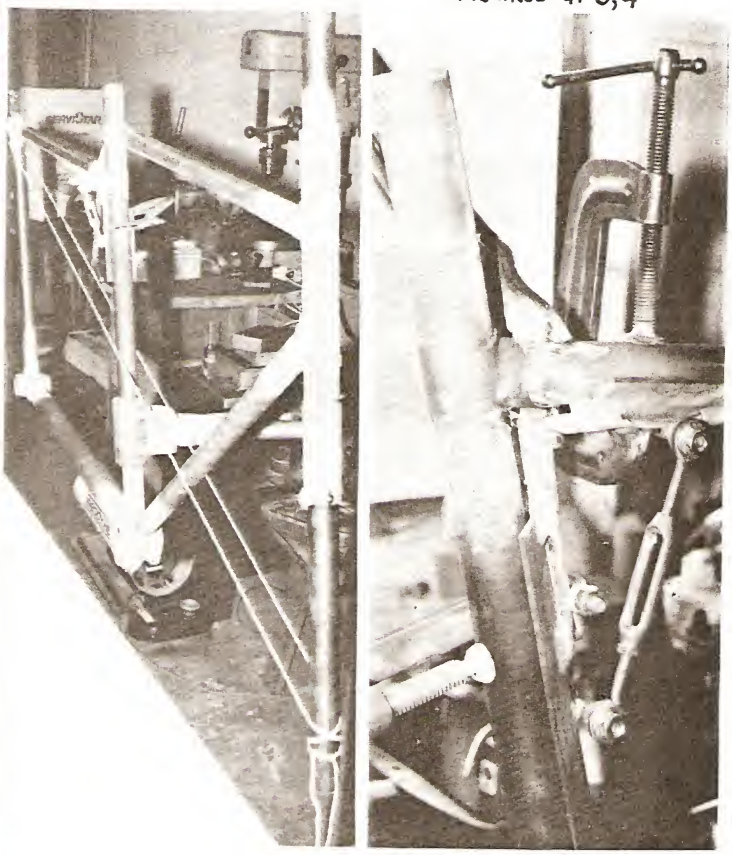
*Mitering is a time-consuming and tedious task for the beginner. If the work height is too high or too low you cannot get the proper feel and wrist action, so try to find the right height for your build. Plant your feet in a stance that allows a smooth straight-line forward arm motion with a smooth follow-through. Remember, a file cuts only on the forward stroke and not on the backstroke, so apply pressure only on the forward movement. Never put pressure on the backstroke or you will dull your files. Apply only enough pressure so that you have a feel of the file cutting the tubing. Never force your tools. A twisting motion of the wrist when mastered

will give the proper radius to your miter. Check your miter frequently, noting the areas needing the most attention.

*Brazing and silver soldering are other skills that improve only with practice. For most of my work I find that a number 2 tip with a neutral flame will take care of my needs. I use regulators to set my flame rather than the control knobs on the torch handle. For me this works very well and you may want to try it. Keep your torch moving in a circular motion over the area being heated. Begin heating the area at the point of greatest material density and work outward to the tubes. Introduce silver solder or brass to the joint. Make the solder or brass flow through the entire joint and add more at the starting point as needed. NOTE: YOU CANNOT GET GOOD RESULTS IF YOUR TUBES, LUGS AND BOTTOM BRACKET SHELLS ARE NOT SHINY CLEAN. Sandblasting is also very effective as a means of cleaning parts for joining.

Figure #3

FIGURES #6,4



Study Richard Talbot's Designing & Building Your Own Frameset, particularly the chart on page 29 showing the color relationship of temperature to heated materials. Practice with your torch by heating scrap bits and pieces of tubing until you recognize the colors. A room or area out of direct, bright light will best allow you to recognize the lower temperature colors.

You can control your heat by various means other than by setting the torch valves: maintaining the distance between flame and frame, and directing the cone of the flame to one side will be part of the skills you will learn to master. Let each joint cool enough to be touched before going on to the next.

This helps minimize stresses and warpage in the frame.

*Cuts, burns and minor fires are a very real hazard so be prepared! Keep on hand band aids and good first-aid materials to take care of cuts. For burns I find the aloe plant is a godsend. Break off a leaf and squeeze the juice on first-degree and mild second-degree burns. It will eliminate all disconfort in less than five minutes. Harsher, more severe burns need medical attention. I also highly recommend a fire extinguisher for those who want' to see this project to its finish.

*Selecting and locating materials for this project can be a problem. Below is a bill of materials for the frame I have been building and describing throughout this writing. I also offer some source material not listed in Talbot's book. Your local bike shop or framebuilder can be a valuable source for your project. When

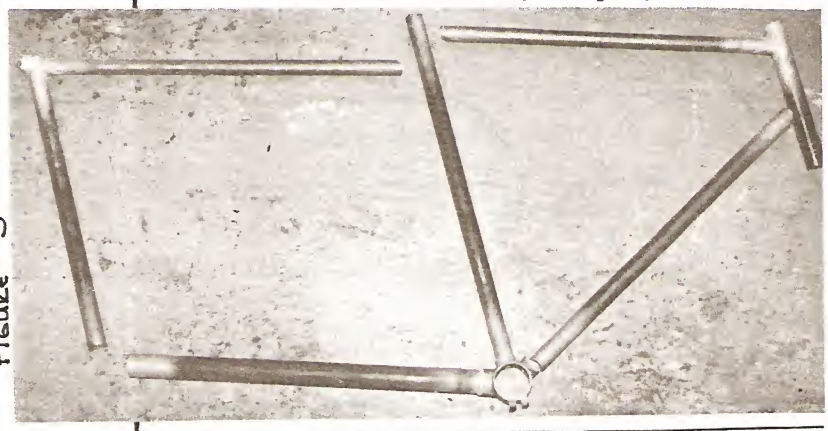


Figure #5

BILL OF MATERIALS

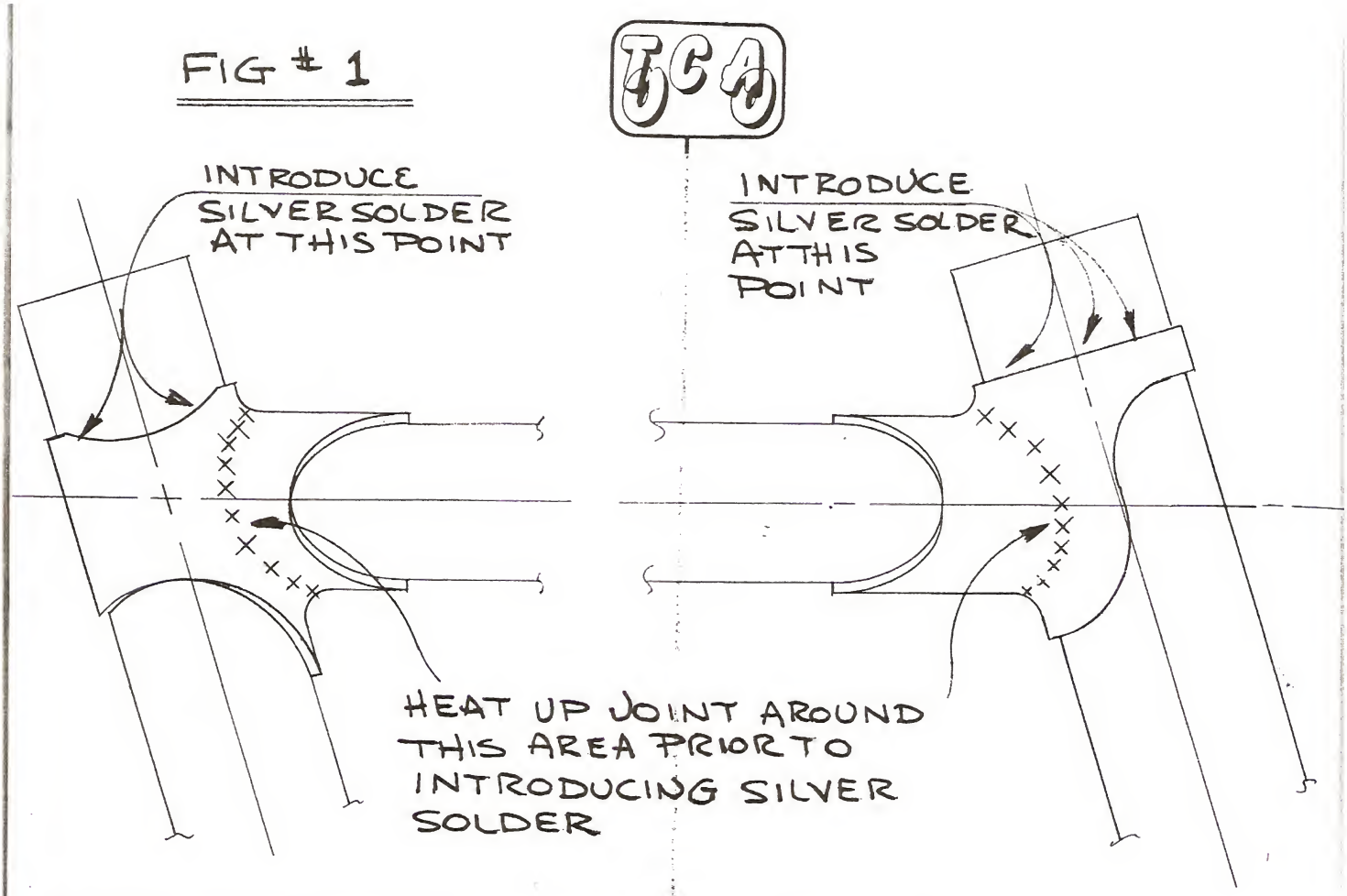
# Req'd	Description
1	Haden Lug Set for tandem
3	Haden lug set - Royal Sovereign without ears on seat tube
4	Haden seat bolt holder #SBH 3
6	Haden seat bolt #SB3 6mm
1	Campagnolo Dropouts #1010
1	Haden Fork Crown for Jack Taylor fork blades
2	Seat tube 4130 chrome moly 1 1/8" o.d. x .035 wall x 24"
1	Downtube 4130 chrome moly 1 1/8" o.d. x .035 wall x 26"
1	Head tube 4130 chrome moly 1 1/4" o.d. x .035 wall x 12"
2	Top tube 4130 chrome moly 1" o.d. x .035 wall x 26"
1	Bottom tube 4130 chrome moly 1 1/2" o.d. x .035 wall x 25"
2	Chain stays 531 Reynolds
4	Seat stays 531 Reynolds 9/16 o.d.
3	Lateral tubes 4130 chrome moly 9/16" o.d. x .035 wall x 60"
1	Bridge tube 4130 chrome moly 1/2" o.d. x .035 wall x 12"
2	Fork blades 531 Reynolds Jack Taylor dimensions
1	Steerer tube 531 Reynolds Length to suit frame
	Braze Ons
9	Bottle bosses T.A. type
1	pump peg
1	bottle boss reinforcement (for pump peg)
1	chain hanger
1	brake cable arch/w. adjust. barrel
4	cantilever brake studs
7	top tube eyes
14	cable stops Andrew Hague type

*Note Reynolds has just made available 1) a tube set for the Haden lugs which should be available by the time you read this. Their tube set uses a pair of laterals that run from head tube to seat stays similar to the Schwinn mens/mens frame

2) Columbus and Cinelli also have tandem tube and lug sets.

Additonal sources: chrome moly tubing- Dillsburg Aeroplane Works, R.D. #3 Saw Mill Rd., Dillsburg, PA 17019; tube sets, lugs, braze-ons- Greenspot Imports, P.O. Box 235, Cornish, ME 04020

FIG # 1



contacting persons via mail to request information, using a self-addressed-stamped-envelope of ample size goes a long way in gaining a reply.

Now, construction starts by preparing the lugs and bottom bracket shells. Clean the edges and any rough spots. You may want to trim and reshape the lugs in a similar manner to the bottom bracket shells described in the May article. I chose to not use the lugs in the set, but will use the royal sovereign design manufactured by Haden. The seat lug is without ears for the binder bolt, so a lug has to be brazed to the lug for clamping the seat post. Generous brass fillets allow me to sculpt the seat lug in a more appealing fashion. Should you decide to do the same, the leftover lugs can be used for practice to gain the feel of the torch. In fact, I suggest you purchase a couple sets of inexpensive lugs and some extra tubing for practice.

Check the fit of the tubes in the lugs and bottom bracket shells. If you find the fit is too tight, file or grind the inside diameter of the lug into a smooth fit. When the tubes fit, check the angle of fit against the angle you designated on your drawing. If you do not know the angle you want, go back to the drawing and establish what it should be. The lug that can cause you some problems will probably be the head tube/downtube lug. If your top tube length varies in either direction from a nominal 22.5" length, then this angle will probably require some lug adjustment. Sometimes a little cold forming is necessary by applying pressure in the desired direction between the two tubes and tapping the lug with a small hammer. For large variations you might need to heat the lug with the torch while applying pressure and persuading with the hammer.

Make sure the lugs and tube ends to be joined are shiny clean. Once the surfaces

are clean, avoid touching them because even transferring the oils or dirt from your hands can cause havoc. Set your angle jig to the head tube angle, apply a generous amount of flux to the tube end you are joining, and proceed to assemble the head tube and front top tube into the prefluxed internal lug surfaces. Clamp the tubes in the jig and double check your setup for accuracy. Make your head tube longer than necessary so that it can be trimmed to length later. The same applies to the seat tube. This extra length allows a natural area to introduce silver solder to the joint which can be cleaned later with a minimum of fuss.

If you jave checked everything and are sure of your setup, light the torch and heat the area all over. Concentrate the heat where the two tubes intersect. When the flux begins to turn clear and watery, you are approaching the temperature at which silver solder can be used. Start by introducing silver solder to your jointures at the area that will be later cut off and faced for the headset. As you introduce silver solder, move your torch in a circular motion. Pull the solder into the joint until it eventually flows completely through the joint and into the very points of the top tube end of the lug.

As you are doing this, keep a close watch on the heat build-up. Move your torch over the whole lug and heat new areas as the silver solder flows into the joint. If progress stops, the joint is probably coated with a dark black carbon build-up. The joint will spit and sputter when silver solder is added. You've reached the point of no return. Let the tubes cool in the jig, then remove the tubes and clean the scale. This is a laborious task made simple with a sand blaster. However, a wire brush, emery cloth, or steel wool with elbow grease and patience will do the trick.

Once everything is cleaned try again. Apply flux and clamp in the jig and try the torch again. This time watch your heat more carefully. (See figures #1 & 2.) Let the tubes cool in the jig. When cool to the touch, remove from the jig and clean. At this point the excess silver solder can be removed and the lug points thinned with a file. Finish the lug with emory cloth until shiny, removing all file marks so that no further clean-up is required.

Repeat the same procedure with the front seat tube/bottom tube (boob tube) and eccentric shell (Fig. #3). Again, repeat the same procedure with the rear seat tube/rear top tube and lug (Fig. #4).

You now have three such assemblies (see Fig. #5) and are ready to flux and assemble the main frame section as shown. After assembling, check the alignment jig and string (Fig. #6). When you are satisfied with the accuracy of alignment, take your torch and tack each remaining joint with just a spot of silver solder. Let each joint cool before spotting the next. Check your alignment after each spot.

In the next issue I describe venting, building the rear triangle, adding the laterals, and constructing the forks. Also, for those of you coming to Tandem '83 at Cape Ann I will have the frameset built up as a complete bicycle using some of the latest components available--Bio pace chain rings and some mountain bike components suitable for tandems.

[Ed. For copies of parts I or II, send a check payable to Tandem Club of America, c/o my attention. Part I costs $1.00 to duplicate and mail. Part II costs $1.50]

BUILD A CUSTOM TANDEM FRAME

PART 1V

by Rodney Moseman

In the last issue of DOUBLETALK we arrived at the moment of truth--actual construction of a frameset. A quick recapitulation to bring us up to date: we prepared the lugs and bottom bracket shells, set up the tubes in jigs and finally lit up the torch. Our

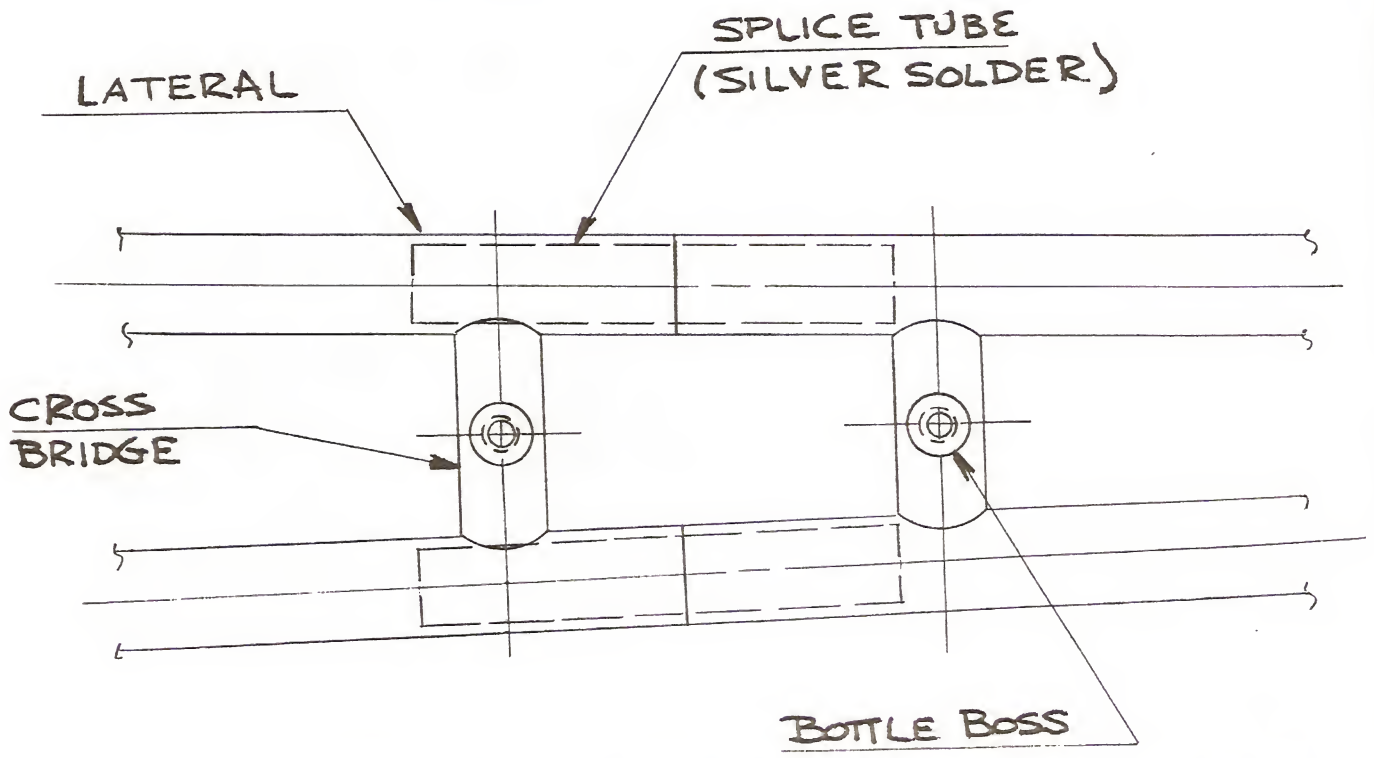
description of soldering tubes together had proceeded from forming three assemblies of tubes and then, finally, assembly of the main frame section.

If everything is satisfactory after checking the alignment of each spot, complete the front seat tube/front and rear top tube joints and let cool. Next, silver solder the down tube/head tube joint and let cool. Follow this step with the front eccentric/down tube joint and let cool. Finally, the rear seat tube/bottom tube and rear bottom bracket shell. When all this is completed and cooled, clean the scale and polish each joint. Then concentrate on the rear triangle.

Since both top tubes and the seat stays are sealed when assembled, it is to your advantage to vent them. This relieves pressure differentials caused by heating the tubes and which can cause voids in the silver solder joints. Vent the top tubes into the front seat tube via small, drilled holes in the seat tube. Other sealed tubes, such as seat stays, fork blades and laterals should also be vented via small holes drilled in inconspicuous places in the tubes. Usually, one per tube is sufficient.

The rear triangle is the next phase of construction. Proceed by laying out the rear triangle to full scale on a large piece of cardboard in order to establish the angle between the seat and chain stays. Slot the stays to fit the dropouts and braze the dropout into the stays. Check the angles with your drawing as you proceed. At this time, a full-size layout is used to establish fork blade length. Slot the fork blades and braze the dropouts in place. Fit the steerer tube to the fork crown and silver solder this sub-assembly. Stow

FIG # 13



away this unit with the fork blades until later. Next, refer to pages 70 & 83 in the Talbot book for selecting style of stay end and seat cluster you wish to use. I chose a semi-wrapover stay for this frame. Fig. #7 shows the plate that caps the seat stay prior to trimming and forming in the assembly.

Trim the seat stay ends and miter the chainstay to the bottom bracket. At this point, have ready the rear wheel you are going to use. Let me emphasize the importance of the wheel being accurately dished and trued. If someone else builds your wheels, personally verify the accuracy of the dish. If you are not satisfied, request that any out-of-dish be corrected before accepting the wheel.

Trial-fit the rear triangle to the frame with the wheel in place. Adjust the dropouts so that the inner faces are as parallel as possible by trial bending and fitting. If you are now ready, flux the mating parts and assemble with the rear wheel in place. Check the alignment with the usual string. Check from dropout to dropout around the head tube (Fig. #8). Wire tourniquets are used to assist the alignment (Fig. #9). My experience is that a 1/16 inch washer between each dropout and axle will compensate for spring-back that usually occurs when the chain stay and brake bridge are added.

Light the torch and silver solder each chain stay to the rear bottom bracket separately. Allow each to cool individually. Next, do each seat stay to the rear seat tube/top tube lug cluster separately and allow to cool before removing the rear wheel. Now, clamp the rear bottom bracket in a vise and run your string check again. If some adjustment is required cold set with the rear wheel removed. When cold setting, maintain the allowance for the two 1/16" washers in the dropout width.

Miter the chainstay bridge and the brake bridge to the frame. Clamp the wheel in place, flux the bridges and silver solder in place.

Again remove the wheel and check the frame alignment. Cold set if necessary and adjust the dropout width for the wheel if necessary. Clean up and polish the seat stay cluster and other joints. Now, refer to your drawings and determine what must be done to add the lateral braces to your frame. I have chosen to miter the laterals to the tubes with which they mate. You may choose to do the same, or you may want to attach it in a manner that is similar to the seat stay cluster.

When you have decided how you will do your laterals, proceed with the necessary fitting and, finally, brazing. Cross-braces are then added between the laterals. When spaced properly, cross-braces can also serve as mounting points for the bottle bosses. You will note that the lateral is a larger diameter where it meets the seat stay, due to the taper of the seat stay. While this presents no functional problem, you may want to splice a seat stay to your lateral for a smoother appearance. The splice is made by fitting a section of tubing into the lateral and a seat tube. After they are joined together, they are fluxed and silver soldered. Place the splice approximately six inches forward of the rear seat tube; the cross-braces for the bottle bosses lie on either side of the splice for further reinforcement. Fig. #13

Clean up your work and polish to this point.

Putting on the little braze-on bits and pieces is the next step. To attach the necessary cable stops, guides, pump pegs and bottle bosses, you must know what you want and where it goes. Determine the controls you are going to use and who will operate them. Then determine the cable routing. Once this is decided you can proceed to silver solder the braze-ons in place.

After the cable stops and guides are in place, make a trial run of cable and casing to determine if the cable is running smoothly. The same applies to the pump peg and bottle bosses. In other words, attach the pump and bottle cages to see if they fit properly. If not, now is the time to make changes, not after you paint the frame. You may also want

to install a chain hanger on the right rear seat stay to allow you to rest the chain on a convenient place when removing the wheel to keep from scratching the chain stay with the chain.

I also like to personalize my frames by silver soldering a monogram "M" on the head tube. I fashion this piece from a scrap of head tubing with a jeweler's saw and Dremel tool. You may want to use your own initial or symbol. Silver soldering the braze-ons in place is a little tricky. You can hold them in place with a vise grips and piece of coat hanger wire or strip stock as shown in Figs. #10,11,12.

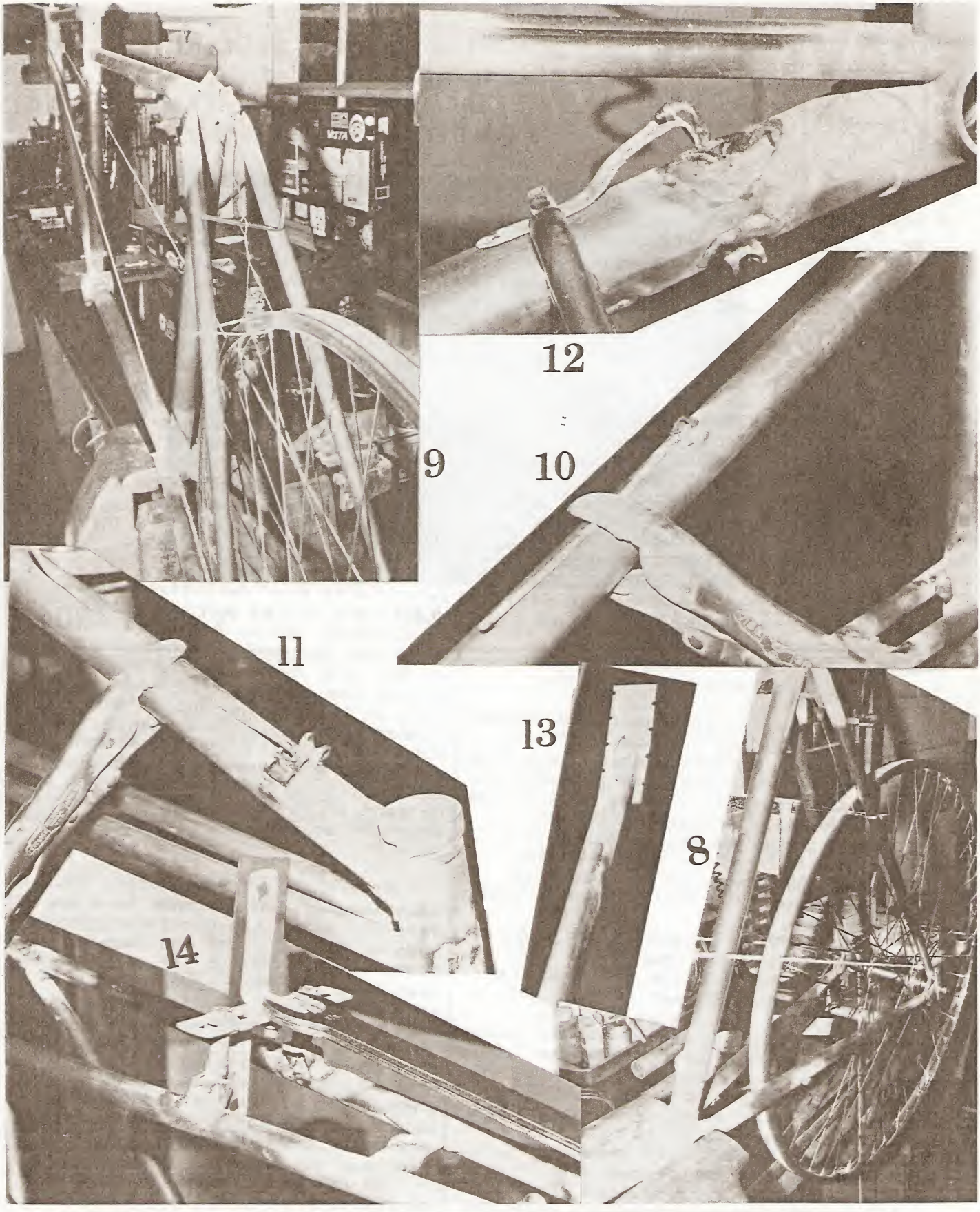
The cantilever brake bosses require that you install the rear wheel and locate the stud position and describe the location on the seat stay. I was able to locate two pieces of scrap hardware to fashion a stud holder along with a little help with some other tools to hold them for brazing (Fig. #13). I am sure by now you will be able to devise a similar means of holding the cantilever studs in place.

The fork blades with attached dropouts and the fork crown with attached steerer tube are the final assembly we need to construct. Trim the blades to an equal length and check that length with your full size drawing. The blades are fluxed and assembled into the fork crown. Again, a properly dished wheel can be used to construct the fork in the same manner as the construction of the rear triangle. I have built a fork in this manner but do not feel comfortable about this method, even though my results were in proper alignment and accurate. I believe he wooden jig illustrated in Talbot's book on page 67 offers a much more reliable means of achieving a properly aligned fork.

Slot the seat lugs with a pair of sawblades placed together in a hacksaw. Take the frame to your local bicycle shop or framebuilder and have the head tube faced or reamed for the headset and also have the rear bottom bracket threads cleaned and the shell ends faced. The dropouts will also have to be adjusted so they are parallel and the derailleur tab aligned.

I cannot stress enough the need to think through this project and the importance of patience and pacing yourself. The end result can be a tander that you can be proud of.

In the next issue we conclude our series with instructions on painting your frameset.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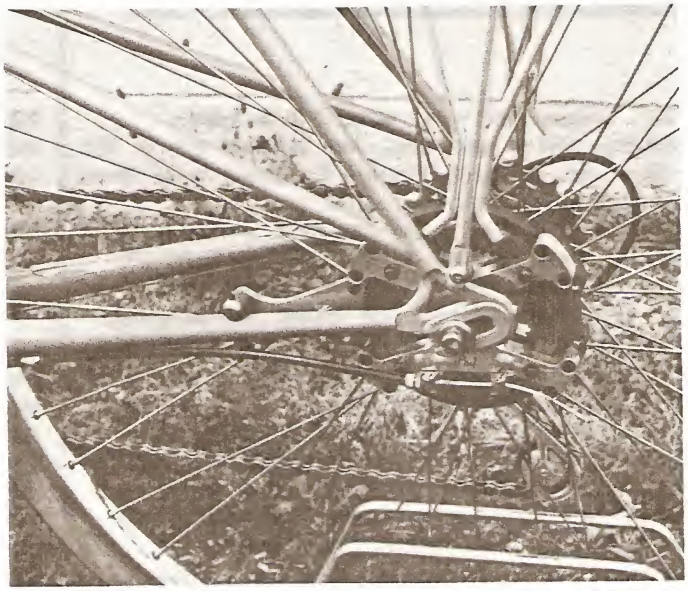
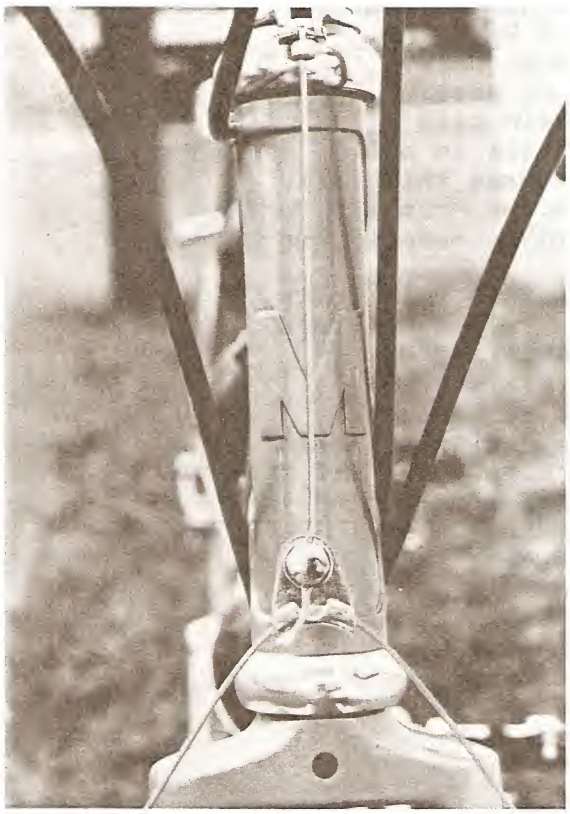
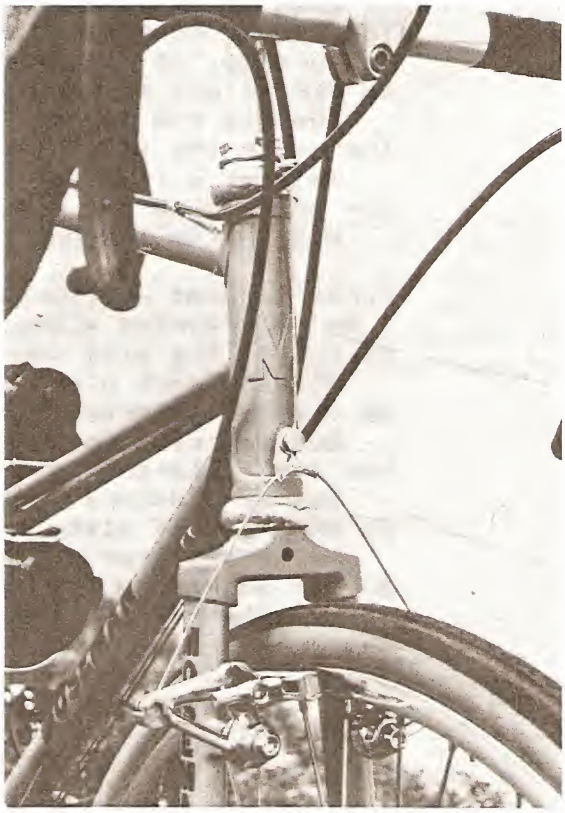
BUILD A CUSTOM TANDEM FRAME

PART V

by Rodney Moseman







For those of you who have been following this series, we ended part IV with the frame and forks brazed and the joints cleaned. Also, all of the braze-on bits and pieces are in place.

There are a few more details that have to be attended to. At this point it will be necessary to hunt up a good bicycle shop or local frame builder for their help. The bottom bracket must be faced and the threads cleaned up with the proper tap to match your bottom bracket threads. The dropouts (on both frame and fork) will also have to be aligned, so they are parallel to each other and perpendicular to the horizontal and vertical center line of your frame (Fig. #1).

The dropout adjustor screws and bottle bosses should also be tapped out. The head tube needs to be reamed and faced for the headset you will be using. And don't forget to take your fork as it too will have to be cut and faced for the fork race and to have the dropouts aligned.

Check everything over closely. Are you certain you are ready to start painting? If yes, let me make a suggestion prior to any painting. Gather your components and assemble the tandem for a test ride. Now is the best time to test out your cable routings for smoothness. After your test ride, you want to be satisfied everything is working okay. If not, make necessary changes. Remove the components and

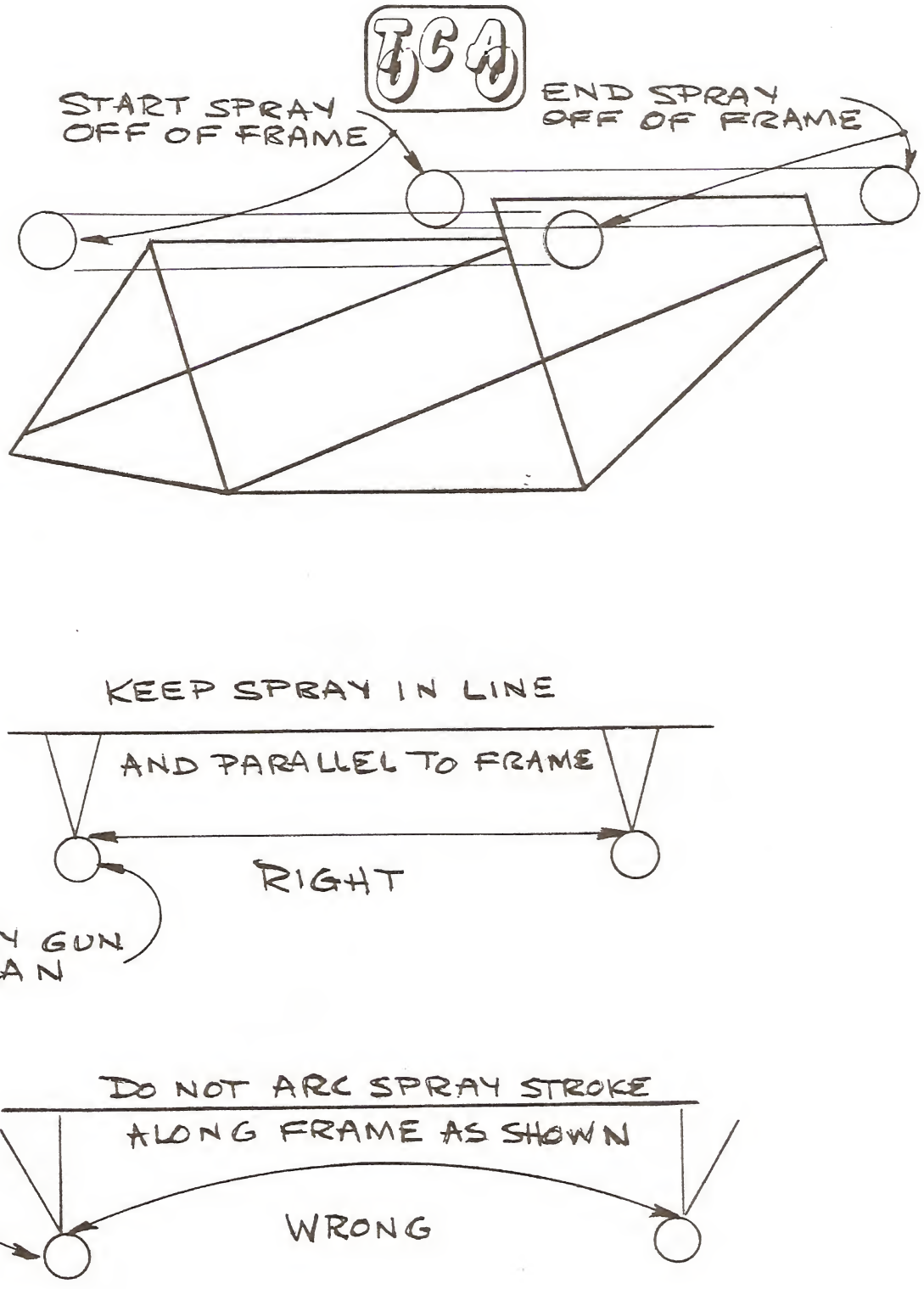

TCA
START SPRAY OFF OF FRAME
END SPRAY OFF OF FRAME
KEEP SPRAY IN LINE
AND PARALLEL TO FRAME
RIGHT
SPRAY GUN OR CAN
DO NOT ARC SPRAY STROKE
ALONG FRAME AS SHOWN
WRONG

FIG #3

ready for painting once you are satisfied. One more suggestion before you paint: sign your work in a simple way. A crest on the head tube would be fitting and proper. Root through your tubing scraps and hunt up a piece of head tube. Then lay out a full-sized monogram on a piece of paper using one or more of your intials. Keep it as simple as possible. Cut out your design with a jeweler's saw and clean up your creation with jeweler's files. Then silver solder your creation to the head tube (Fig. #2). An alternative to a cutout is to have a jeweler who specializes in engraving monogram a pre-shaped piece of head tube that you shape up for a crest. Specify that the engraving be deep cut so that detail is not filled with paint in the finishing process.

The frame must be clean in order to properly receive paint. Strips of emery cloth can be used in shoe shine fashion to polish the frame. Chemical cleaners or etches can also be employed to prepare the frame surface.

IN ALL CASES BE SURE TO READ AND FOLLOW INSTRUCTIONS FOR ALL PRODUCTS YOU WILL BE USING. DO NOT TAKE HEALTH WARNINGS LIGHTLY! THEY ARE FOR YOUR PROTECTION!

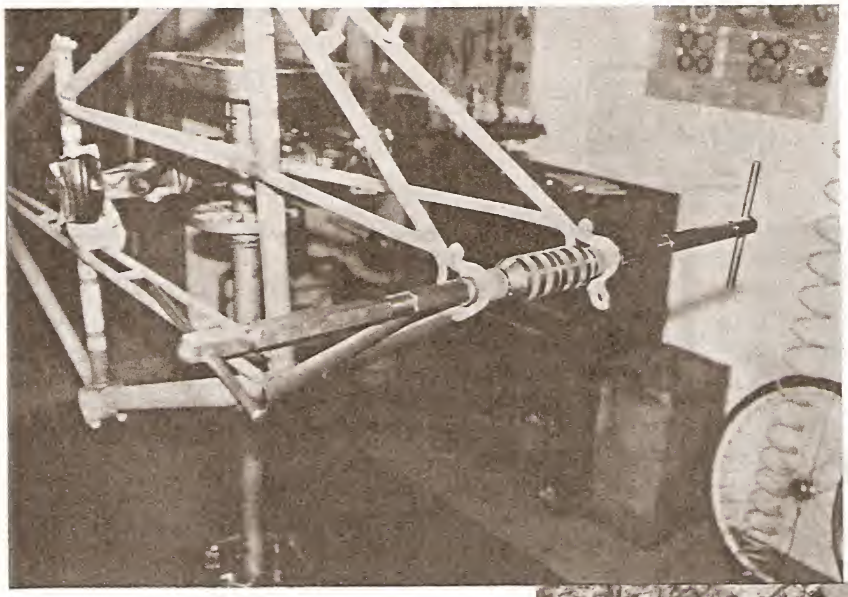
When your surface is prepared, you are ready to paint. You may elect to farm out the painting to a profes-sional, or do it yourself. There are many shops and framebuilders that can do the work for you. You may even be able to find an auto body shop that can do the work if you are not particular about color. Or you may find a body shop ready to paint with a color you like. Swing a deal so your frame uses leftover paint that would otherwise be discarded. Also, see if the shop has some leftover paints that could do the job. If a body shop is painting your frame, find out what type of paints they are set up to use. Then select a color that fills your needs. Doing this can keep costs down because thinners and other special agents necessary for your paint will be part of the shop's normal supplies and will not have to be purchased just for your job.

Since painting a frame will not use even a pint of paint, purchasing a minimum quantity of a quart would be waser. Commercial thinners and other chemicals are also sold in minimum quantitites. For example, DuPont's Imron would cost over $130 just for the materials, due to the minimum container quantities for the various primers, thinners, catalysts and clear coats necessary to use this type of paint system.

Paint dealers supplying specific brands of paints can also give you the names of shops that use that type of paint. In some cases, shops that specialize in a paint, or in custom painting, may also have a mixing bar or machine that allows pints to be mixed in your color choice. Again, since this type of shop already has the other materials for this paint, your material costs are kept more in line.

For those of you doing the painting, there are several things you will need. The most important is a clean, well-ventilated work area. Once you select the type of paint, stick with it. Do not switch brands or types in the middle of the paint job. For example, use only the primer rec-ommended by the finsh coat manu-facturer. The same applies to clear coats, thinners and such.

You can get a satisfactory paint job using spray cans. Just remember to be patient and read the instructions. Your paint dealer can probably provide a booklet or pamphlet of helpful hints on spray painting. Remember, several light coats are much better than one

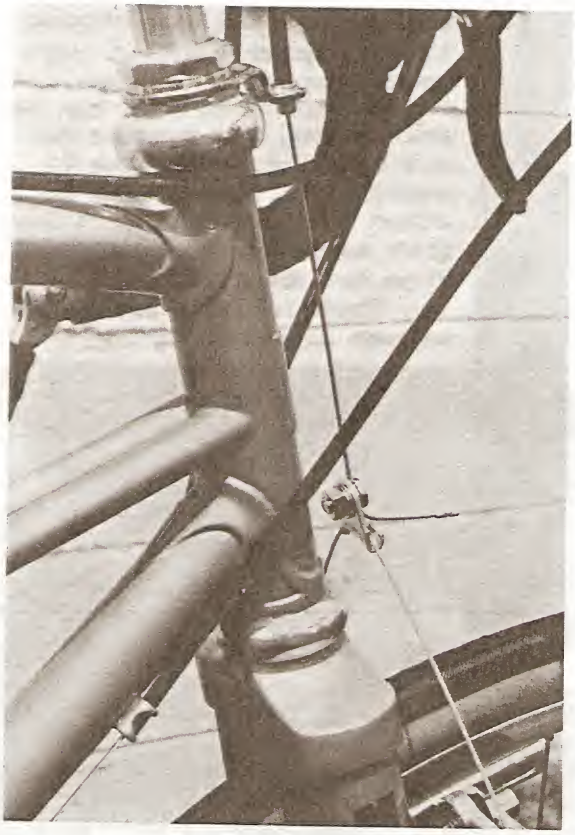


heavy coat. If you choose to use spray cans, I suggest you use a lacquer paint since lacquer can be wet sanded and rubbed out with rubbing compound to smooth out runs, sags or other imperfections. A 400 grit wet/dry paper works fine for this purpose.

Those of you wanting to use an airbrush or spray gun supplied by air compressor or air tank will have a wide range of paint types to choose from. One such paint I have seen used is formulated for model airplanes. And when applied to manufacturer's instructions, seems quite satisfactory. Paint can also be applied with an airbrush and low volume compressor.

The paint I am referring to is made by K & B and sold as Hohhy-poxy, an epoxy, two-part paint with a primer and clear coat available. Since model airplanes are small, the paint comes in small quantities and is suitable for home shop application. I do recommend an air mask be used and the area be well-ventilated. Color selection is also pretty good. Consult a local hobby shop that specializes in radio-controlled model airplanes.

When spraying, apply a sufficient coat so that the paint appears wet and glossy. Too much paint and it will run; not enough paint and the coat will be dull and flat. You may want



to practice on scrap tubing or on an old frame before trying your tandem.

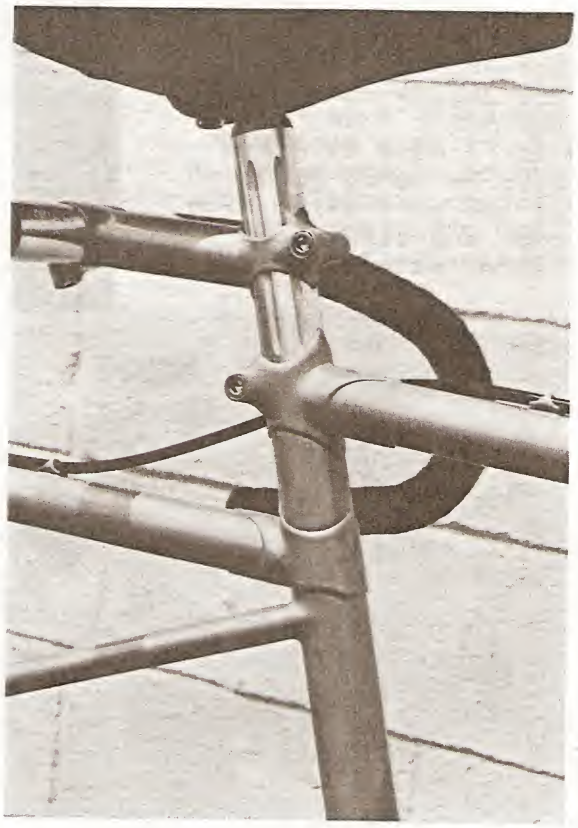
On my frames I use a paint manufactured by Martin Seynour under the trade name of Nitram. This is a polyurethane enamel similar to Imron but with better chip-resisting qualities. This paint has minimum container quantities and is highly toxic. If you can find a shop specializing in this paint, you might be able to purchase a quantity of material for your project.

If you use a Nitram, Imron or Delthane paint, wear a charcoal filter mask and spray in a ventilated area. Failure to follow these simple safety precautions could result in an unfinished tandem and a single tandem rider looking to replace a dearly departed partner.

Suspend your frame by hooks made from a coat hanger and you are ready. Wipe down the frame with a cloth, or wet it with thinner to remove any oily deposits that will be left from your hands just from handling the frame. When the thinner dries, go over the frame with a tack cloth to remove lint and dust.

Let me reiterate this last point: Do not touch the frame with your bare hands because the oils present in the skin can prevent proper paint results.

Start painting with the primer and, after testing the spray pattern of the nozzle pointed away from the frame, lightly spray once the areas of the frame where the tubes intersect. After that, spray each tube by starting six to eight inches before the tube, move in a smooth, straight-line motion, and end six to



eight inches after the tube. By starting before the tube and ending after the tube, you eliminate the misflows that can occur due to a spray nozzle that spits and sputters. Prime all of the frame and allow to dry according to directions.

Once the primer coat is dry,

examine your work carefully to see that your coverage is complete without misses and thin paint areas. Runs and sags can be wet sanded smooth. Touch up any areas needing attention and again allow to dry. The same procedure is used for the finish coat and clear coat if you elect to use one.

You may want to apply decals or transfers to identify your work. Water-slide-type decals may be available in local paint stores. These sheets of letters can be cut out and applied to your frame to spell out your name or a pet name you choose. If you cannot find water-slide decals, rub-off letters are available in art supply stores in various type styles and sizes. Both types of transfers can be protected from minor scrapes and mishaps with a clear coat. Another word of caution: some types of transfers are not compatible with certain clear coatings. I suggest applying a lettering sample to a painted scrap of tubing and then covering with clear and allowing it to dry. If all appears well, go ahead. But if the lettering dissolves or wrinkles, you will not be able to use a clear coat on the letters.

Allow the frame to dry approximately four days before you make any attempt to assemble your bike. This will ensure hardening, so you will have minimum paint damage while undergoing the rigors of head set and bottom bracket installations, and component assembly.

In presenting this series I have tried to describe the process of building a tandem frame. There are many alternative ways and many other tricks of the trade. You may discover some as you go along. Let me close in saying that since this newsletter is always begging for articles, please write of your experience or tips for others.

In closing I have included several pictures of the now finished tandem pictured as it was being built throughout this series. If you build a tandem from this article, I would appreciate hearing how your project went and seeing a photo of the results.

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